Chapter 3 – ESTIMATED VOLUMES OF SOIL FOR REMEDIATION

3.1 Introduction

This chapter describes the following:

- Site remediation units are defined in Section 3.2;
- Section 3.3 describes the procedures that were used to estimate the impacted soil volumes, and present the volumes of in-place soils by RU type; and
- Section 3.4 summarizes the total estimated soil volume that is addressed in this FS.

3.2 Definition of Remediation Units

RUs are generally defined in this FS as areas of the Site with similar future land uses. The exception is the Miscellaneous Small RUs where the RUs were grouped by distinct constituent types, concentrations, or where deposition of those constituents is believed to have occurred by similar mechanisms. The names and descriptions of the remediation units that are used throughout this FS report are as follows:

Golf Course RUs: All property inside the golf course footprint. There are nine golf course RUs comprising 187 acres. The amount of remediation required in these RUs is related to the alternative selected and ranges from the entire 187 acres to less than 100 acres under a limited cap/cover scenario. Under a limited cap/cover scenario, roughly 73 acres would be used for soil placement and cap/cover.

Open Space RUs: These RUs represent the open space areas of the Site. Four open space RUs occur on-Site. They are North Sequalitchew Creek Canyon, South Sequalitchew Creek Canyon (broken into two RUs) and the Old Fort Lake Greenbelt. These RUs represent 73 acres.

Commercial RUs: All Site property planned for commercial development. There are nine Commercial RUs consisting of approximately 334 acres.

Historical RUs: These RUs make up the areas of the Site that have historic significance. Three historical RUs occur on-Site consisting of approximately 6 acres. They are the Fort Nisqually Cemetery (45PI404), the south Shell Midden (45PI72), and the 1833 Fort Nisqually Site (45PI55. An additional historic site, the small Shell Midden (45PI485) along Sequalitchew Creek, is included in the Sequalitchew Creek open space RU and will be addressed in the same manner as the remainder of that RU.

Miscellaneous Small Remediation Units: These remediation units are those that have unique characteristics and are small in size (less than 2 acres) and volume (requiring excavation of less than 5,000 CY). These unique characteristics could be any of the following:

- Similar mixture of contaminants;
- Similar deposition method (localized spill, localizes disposal site, etc.);
- Small occurrence(s) of a single contaminant;
- Contaminant “hot spots” discovered during final cleanup;
- Debris; and
- Location: An example would be sections of the Narrow Gauge Railroad track within Sequalitchew Creek Canyon. This RU is represented by the linear length of the track and the width of track bed from the toe of the uphill slope and the crest of the downhill slope.

3.3 Soil Volumes

Estimates of soil volume were based on interpretation of sample data collected during the RI and subsequent ISR or characterization efforts. Volumes reported below are pre-remedy estimates. The

actual amount of soil to be excavated during the cleanup action will increase or decrease based on effectiveness of the remedy chosen as verified by the actual field sampling data (i.e., confirmation samples) obtained during the cleanup action, or the error inherent in the volume estimation process.

Only in-situ soils with lead and/or arsenic concentrations above the respective CLs or RLs are included in the estimated soil volumes for remediation. Additional volumes of non-lead and non-arsenic soils are associated with Miscellaneous Small RUs. Estimating the final volume of in-place impacted soil that must be addressed in miscellaneous small units with certainty is very difficult. These units are small and have many unique characteristics. For these units, an alternate approach based on Site knowledge and good technical judgment was developed that will provide reasonable estimates. This approach estimates the total volume associated with contamination discovered as a result of confirmation sampling as 0.5% of the total know volume of arsenic and lead impacted soil. As such, the total volume associated with Miscellaneous Small RUs equals the total known volume plus 0.5% of the total lead and arsenic impacted soil volume Site-wide.

3.4 Soil Volume Estimation Procedures

Soil volumes were estimated using the Pre-RI and RI analytical data and verification sample analytical data from the ISR and maps generated for the RI and RA reports. Excavated volumes are calculated by multiplying the in-place soil volumes by a "fluff" factor, which accounts for volume expansion that results from excavation. Based on laboratory and field measurements of Site soils, an excavation fluff factor of 1.25 was used. These volumes, in some cases, were converted to tons on a 1 CY = 1.4 tons basis. This conversion was developed from actual site data recorded during the 2001 Soil Screening Interim Cleanup Action.

Generally, the excavation depth used to estimate excavated soil volume was 1.25 feet. This estimate is based upon the 95% upper confidence level (UCL) of the actual vertical extent of lead and arsenic contamination statistically above the Site-specific RLs (determined to be 1 foot in depth) and a reasonable safety factor of 25%. The following assumptions/process were used to determine the 95% UCL.

- Each sample point was evaluated to assess the vertical extent of contamination. The depth of each constituent was determined by using the bottom of the sample interval above the RL in a test pit, boring, or hand auger exploration. (No interpolation was used when determining the depth). When surface samples only were above the RL, the depth was set at one foot.
- Once the sample evaluation was complete the sample data was evaluated using Ecology's Threefold Statistical Process to determine at which depth compliance could be reached.

Due to the complexity of the Site and the difficulty in predicting the presence and location of isolated occurrences of lead and arsenic contamination above the Site-specific RLs, four separate methods were used to determine the lateral extent of contamination in each RU.

- For localized contamination, the lateral extent associated with a sample point above the RL was assumed to be 25 feet from the limit of the bermed area or limit of the former building foundation. This estimate was based on best professional judgment of a reasonable scenario for deposition of the constituent, such as construction material (lead sheeting on floors, workbenches). When no depositional constraints were present near the sample location, a 25-foot-square area centered over the sample location approximated the limit of impact. When two or more adjacent samples were above the RL and none of the depositional constraints were present, the area between the sample locations was included.
- The estimate of impacted soil volumes in the Narrow Gauge Railroad Tracks (NGRR) was based on sample analytical results which show that arsenic concentrations decreased significantly beyond 25 feet (see the RI). The length of impacted NGRR was interpolated between sampling locations with concentrations that are above and below the RL.
- For those areas of the Site where concentrations of lead and arsenic contamination approached the RLs, the prediction of the presence or absence of contamination becomes

difficult and impractical. In these areas the entire square footage of the RU was deemed to be contaminated.

- Debris volume was determined assigning an in-situ volume of 740 CY per known location. This estimate assumes a 50-foot by 50-foot lateral occurrence, which is 8 feet deep.

Note that these assumptions were used only for estimating impacted volumes. Actual volumes and limits of excavations will be determined by confirmation sampling conducted during the cleanup action.

3.4.1 In-Place Volumes of Impacted Soil

The following estimates of soil volume were calculated using the assumptions listed. Table 3-1 presents the estimates of in-situ volume of impacted soils by RU. They represent impacted volumes prior to the selection of any remedy. The selection of a remedy will change these volumes either upward or downward.

Golf Course RUs: The estimated in-place contaminated soil volume in the golf course RUs is 301,693 CY. Using the "fluff" conversion factor of 1.25, the excavated volume is 377,117 CY.

Open Space RUs: The estimated in-place contaminated soil volume in these RUs is 117,773 CY. Using the "fluff" conversion factor, the excavated volume is 147,217 CY.

Commercial RUs: The estimated in-place contaminated soil volume in these RUs is 554,987 CY. Using the "fluff" conversion factor, listed above, the excavated volume is 693,733 CY.

Historical RUs: The in-place contaminated soil volume in these RUs is 9,680 CY. Using the conversion factor, listed above, the excavated volume is 12,100 CY.

Miscellaneous Small RUs: The known volumes of the soil requiring remediation, for each Miscellaneous Small RU, are as follows:

- Similar mixture of contaminants: There are 3 locations where this type of occurrence is present. Using the criteria listed above this equates to approximately 173 CY excavated volumes of soil.
- Similar deposition method: There are 9 locations where this type of occurrence is present. Using the criteria listed above this equates to approximately 184 CY excavated volumes of soil.
- Small occurrence(s) of a single contaminant: There are 113 locations where this type of occurrence is present. Using the criteria listed above this equates to approximately 4,689 CY excavated volumes of soil.
- Contamination "hot spots" discovered during final cleanup: Since the impacted soil quantity in "discovered hot spots" is unknown, the impacted soil volume will be estimated at 0.5% of the total lead- and arsenic-impacted soil. As such, the in-situ contaminated soil volume in these RUs is 4,630 CY. Using the "fluff" conversion factor of 1.25, the excavated volume is 5,788 CY.
- Debris: Debris occurs both as stockpiled material and in-situ. Interim source removal/cleanup actions have discovered 20 discrete in-situ debris locations. Their depth and regulatory status is unknown. As such, it was assumed that each of these locations represent 740 CY excavated volume of contaminated debris for a total of 18,500 CY.
- Sequalitchew Creek NGRR: Approximately 2,000 linear feet of NGRR track bed remains in Sequalitchew Creek Canyon that will require remediation. This represents an estimated in-place volume of impacted soil of 1,852 CY. Using the "fluff" conversion factor of 1.25, the excavated volume is 2,315 CY. Estimated Soil Volumes Summary

Table 3-1 presents a summary of estimated in-place soil volumes above RLs for the Site organized by RU. The total excavated volume of soil associated with each remediation unit is also presented in the table. The total estimated volume of excavated soil and debris that may require remediation is approximately 1,261,815 CY. Figure 3-1 identifies the areas where mass excavation will occur.

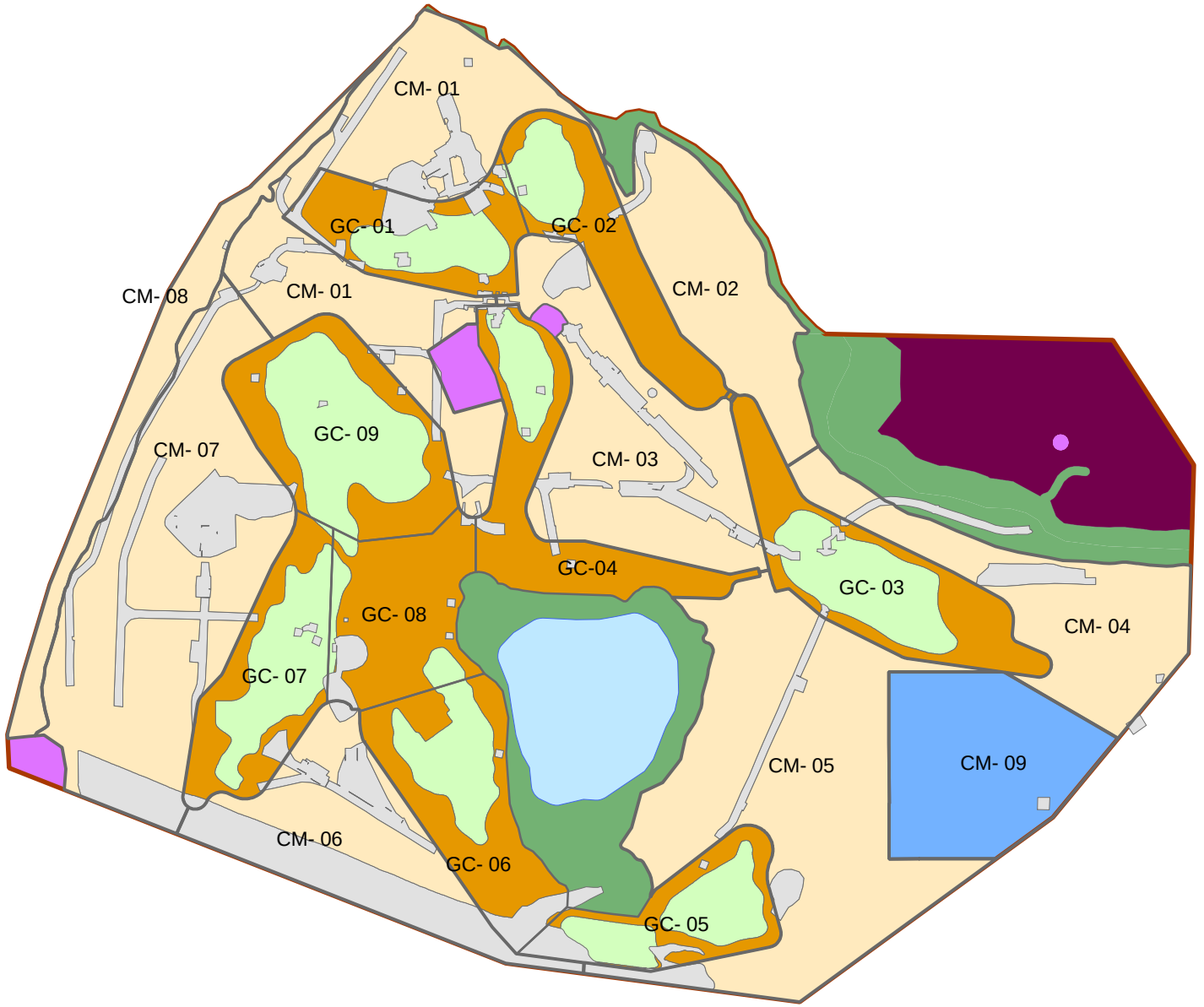
These estimated soil volumes are to be used as the basis for:

- The screening of technologies and process options (Chapter 4);
- Screening and analysis of alternatives (Chapters 6 and 7);
- Selecting the preferred alternative (Chapter 8); and
- The development of scope for treatability studies (Chapter 5).

Table 3-1 – Estimate of In-Situ Impacted Soil Volume for Each RU

Remediation Unit Type - Mass Excavation	Number of RUs	Acreage	In-situ Volume (CY)	Excavated Volume (CY)	Weight in Tons
Golf Course	8	187	301,693	377,117	527,963
Commercial	11	344	554,987	693,733	971,227
Open Space	3	73	117,773	147,217	206,103
Historic	3	6	9,680	12,100	16,940
Miscellaneous Small RUs	**Occurrences**				
Similar Mixtures	3		139	173	243
Similar Deposition	9		147	184	257
Single Contaminant	113		3,751	4,689	6,564
"Hot Spots"	NA		4,630	5,788	8,103
Sequalitchew Creek NGRR	2,000		1,852	2,315	3,241
TOTAL VOLUME - Soil			994,652	1,243,315	1,740,641
Debris	20		14,800	18,500	25,900
TOTAL VOLUME - Soil and Debris			1,009,452	1,261,815	1,766,541

Notes:
NA = Not applicable.



Legend

- Historical Area
- Golf course area to be scraped
- Commercial area to be scraped
- Old Fort Lake
- Open Space
- Consent Decree Boundary
- ISR Excavations SOC
- Area in Compliance
- Industrial Area
- Placement Area

Notes

Scraped area omits Placement Area, ISR Excavations, Historical Areas, Open Space, and Industrial Areas in the calculation.

Total commercial acres to be scraped: 251.9 acres

Area scraped in each unit:
CM-01: 38.9 acres
CM-02: 23.8 acres
CM-03: 30.6 acres
CM-04: 26.3 acres
CM-05: 60.0 acres
CM-06: 12.4 acres
CM-07: 45.3 acres
CM-08: 14.6 acres

Total golf course acres to be scraped: 104.4 acres

Area scraped in each unit:
GC-01: 7.7 acres
GC-02: 13.2 acres
GC-03: 13.1 acres
GC-04: 15.6 acres
GC-05: 5.8 acres
GC-06: 13.2 acres
GC-07: 8.7 acres
GC-08: 15.2 acres
GC-09: 12.0 acres

ISR: Interim Source Removal
SOC: South of Creek

Historical location in the Industrial area is the Methodist Mission Marker. Actual location of the mission is unknown.

Scraped Units

Former DuPont Works Site

July 2003

Figure 3-1